(12) UK Patent Application (19) GB (11) 2 179 404 (13) A

(43) Application published 4 Mar 1987

(21) Application No 8619871

(22) Date of filing 15 Aug 1986

(30) Priority data
(31) 8520529 (32) 15 Aug 1985 (33) GB

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(51) INT CL⁴
F04B 43/12 45/08

(52) Domestic classification (Edition I):
F1U 1 4 7 8 A
F2P 1A12 1B5B 1B7D 1B7J A29 F5

(56) Documents cited
GB A 2022041 GB 1272252 GB 0637429
GB 1355651 GB 1183023 EP A1 0015180

(58) Field of search
F1U
F2P
Selected US specifications from IPC sub-class F04B

(54) Peristaltic device

(57) A peristaltic duct, e.g. in a peristaltic pump motor or valve, is such that in its relaxed or unstressed state the flow passage therethrough is occluded. In use, an opening force is applied so as to open said flow passage and allow flow of fluid therethrough, e.g. gas, liquid, or liquid containing suspended solid(s). The opening force may be applied to the duct by a number of spaced actuators (31, Fig. 4, not shown) sequentially operated by crank means or, alternatively, may be applied by spaced electromagnets and an associated series of permanent magnets (48, Fig. 5) or an associated permanent magnet flexible strip (64, Fig. 6). In another arrangement the duct passes through a torroidal chamber 71, Fig. 7, which is evacuated to cause the duct to open its flow passage. However, the chamber contains some liquid having a suspension of magnetically responsive particles so that when subjected to a magnetic field by energisation of an electromagnet 74 to 77, the liquid suspension between the associated pole pieces of the electromagnet will exert a pressure sufficient to close the adjacent region of the duct.

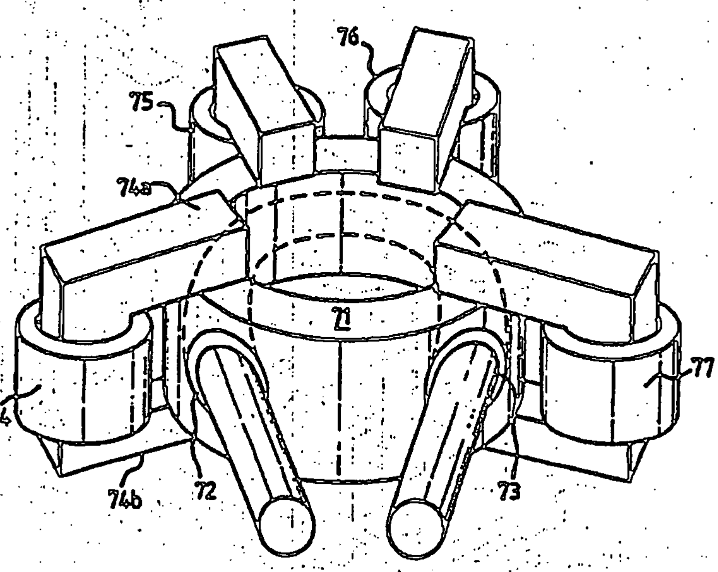

FIG.7.

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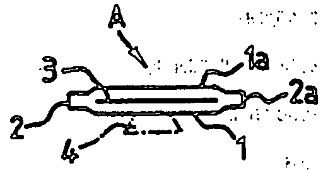


FIG.1.

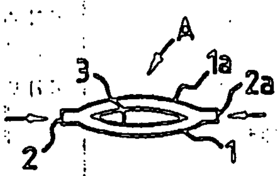


FIG.2.

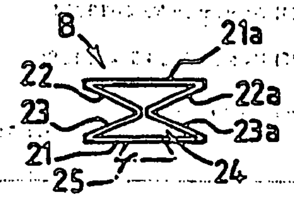


FIG.3.

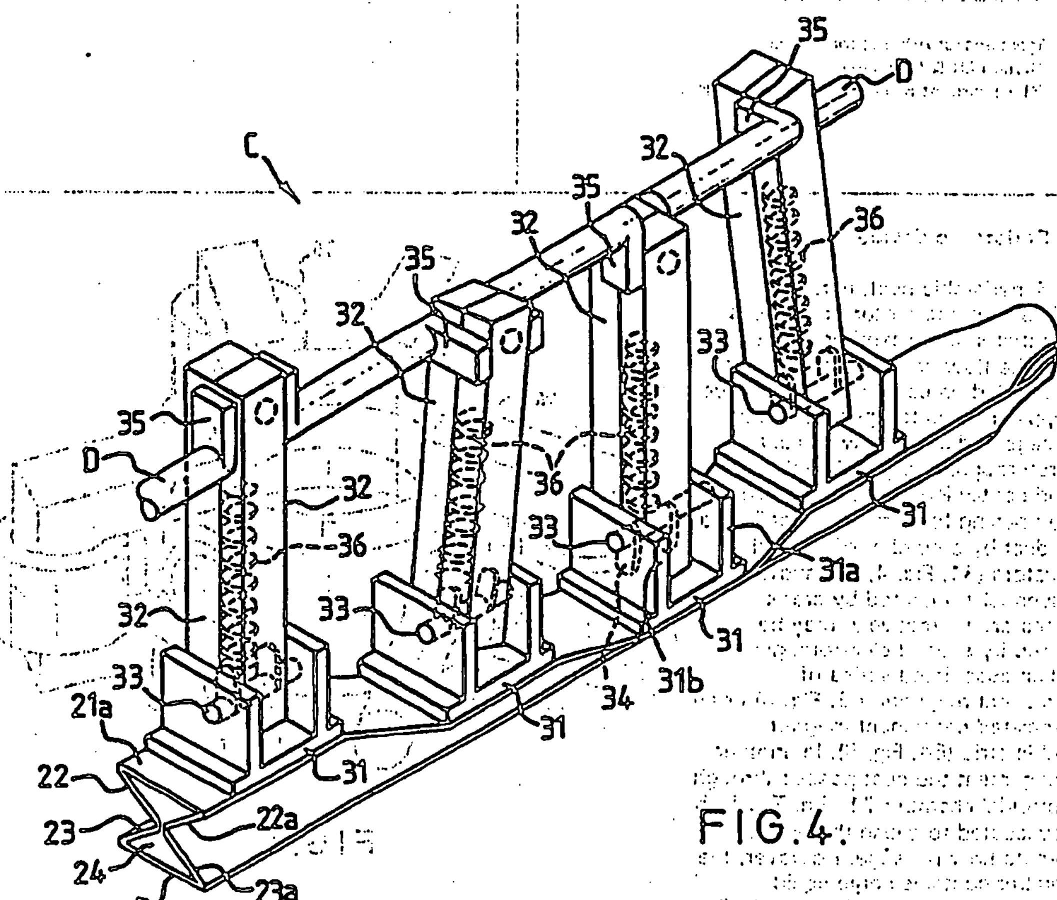
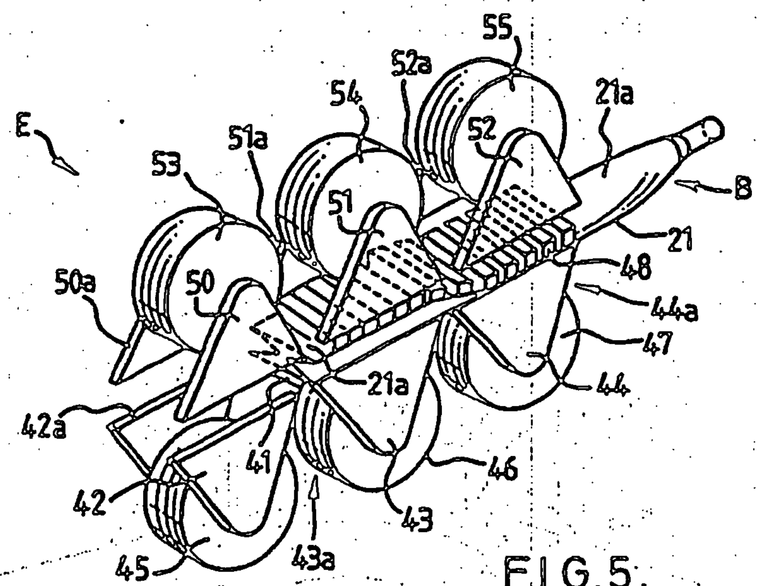


FIG.4.


E
55
52a
54
21a
52
51a
53
B
51
21
48
50a
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44a
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21a
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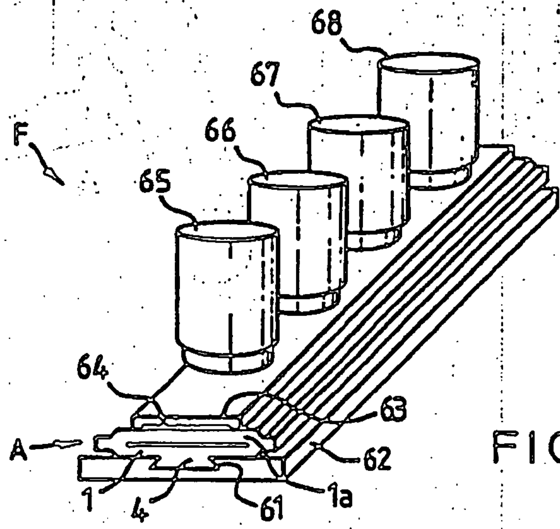
46
42
43
45
43a

FIG.5.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67
66
F
65
64
63
A
62
1
4
61
1a

FIG.6.

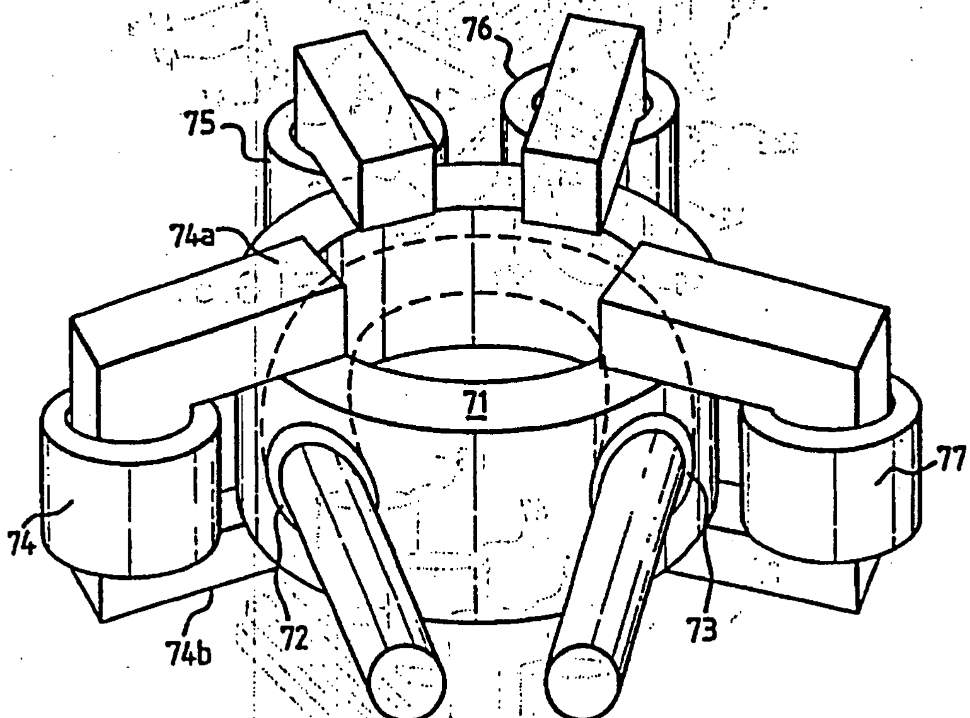
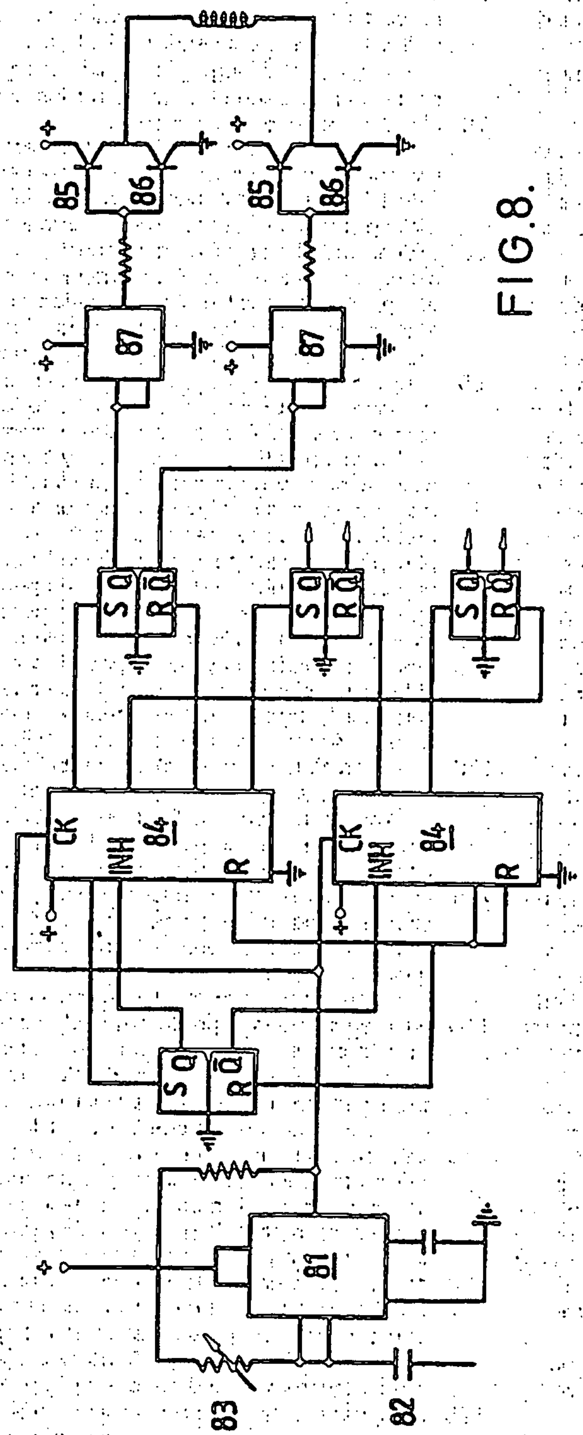


FIG.7.


85
86
87
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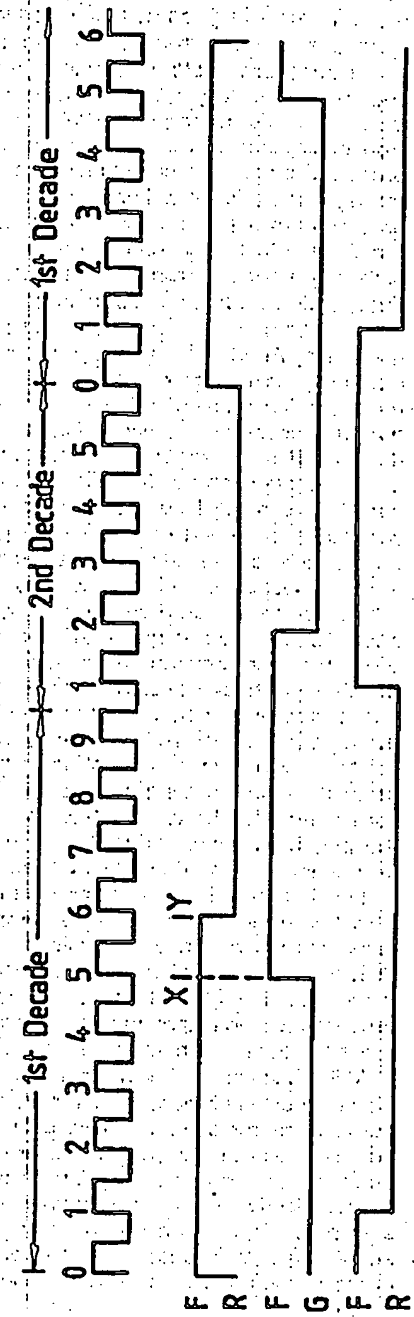
CK
INH
R
S Q
R Q̄
81
82
83

FIG.8.


1st Decade
2nd Decade
1st Decade
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X1
IY
F
R
F
G
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FIG.9.

SPECIFICATION

Peristaltic ducts pumps motors

For the efficient performance of a peristaltic pump or motor, the peristaltic passage should be sufficiently (e.g. completely) closed in at least one region or zone of its length. Conventional peristaltic ducts are circular in cross section in their fully relaxed state such that their peristaltic passages are fully open. Occlusion or collapse of the peristaltic passages is produced by applied pressure which flattens the duct(s) sufficiently. For complete occlusion or sealing of a said region or zone, this flattening of a 'naturally' round tube involves a high degree of distortion of the material of the duct, and is a fundamental limitation on the design and performance of existing peristaltic machines. Another limitation is reliance on the material regaining its original shape by resilient recovery. Time taken for resilient recovery between successive occlusions limits volumetric delivery. Resilient recovery is also affected by other factors such as the difference in pressure between the fluid within the peristaltic passage and the external surroundings. The temperature of the resilient material also affects its recovery, and so does any 'ageing' effect due to repeated severe flexing of the duct. Taken together the above factors or problems limit conventional peristaltic pumps to relatively small sizes, working at modest outlet pressures with very limited delivery if the inlet pressures are significantly sub-atmospheric. Even in small peristaltic pumps, at other than slow cycling speeds and low pressure differences between inlets and outlets, the peristaltic ducts can undergo progressive permanent deformation in their dimensions, resulting in pump delivery change with time. This further limits use of these pumps to applications where a highly consistent volume delivery is needed over an appreciable period. It has now been found (in accordance with the present invention) that the above problem(s) can be reduced or overcome.

A first aspect of the present invention provides a peristaltic duct (e.g. for a peristaltic pump or motor or valve), said duct being adapted such that its relaxed or unstressed state is occlusion of the peristaltic passage so as sufficiently to close the cross section of said passage, at least one opening force being applicable to said duct so as to open said cross section and allow flow of fluid therethrough.

A second aspect of the present invention provides a peristaltic pump, motor or valve comprising:

at least one peristaltic duct of the first aspect of the invention; and

at least one stress means for stressing said at least one duct so as to open at least one said cross section and allow flow of fluid therethrough.

A third aspect of the present invention provides a method of peristaltic flow of fluid, comprising utilising at least one peristaltic duct of the first aspect of the invention, or utilising at least one pump, motor or valve of the second aspect of the invention. Said fluid can be any suitable fluid, e.g. gas, liquid, or liquid containing suspended solid(s), for instance blood or other delicate matter.

The peristaltic duct of the first aspect of the invention eliminates the conventional need to select from a narrow choice of materials for making peristaltic ducts. The inventive duct widens the choice of duct materials, and hence both the potential operating life of the pump, motor or valve. The invention also permits many applications of its ducts. For example, if the ducts are made from relatively floppy materials (e.g. a suitable polymer, for instance polyethylene or polyvinylchloride), the duct will be capable of undergoing many cycles of operation. The duct may be made from semi-rigid materials; e.g. a suitable polymer, for instance polypropylene; or a suitable metal, for instance steels, stainless steels, or phospher bronzes to give enhanced pressure operation or enhanced pressure/temperature operation compared with materials which have to exhibit both resilience and flexible properties. The duct(s) may be disposed in any suitable manner, e.g. at least partly linearly or at least partly toroidally. One preferred duct is tubular. Another preferred duct is bellowslike. The convoluted portion(s) of the bellows section(s) may open inwardly or outwardly according to application. Said duct is suitable for any useful application thereof. Said peristaltic passage can have any suitable shape. Its maximum cross sectional area can change or not change along at least one portion of its length, e.g. and/or enable compression or expansion of gas.

Preferably, said at least one stress means is adapted to open a predetermined succession of said cross sections of the peristaltic passage of at least one said peristaltic duct of the invention. If desired, at least one said stress means can aid closure of at least one said peristaltic passage. One preferred stress means for said successive opening comprises at least one crank means; and at least one connecting means (e.g. connecting rod means) communicating between said at least one crank means and at least one said duct so that at least one rotational movement of said crank means will provide at least a portion of said successive opening. Another preferred stress means for said successive opening comprises at least one magnetic means; and at least one magnetically responsive means for magnetic communication between said at least one magnetic means and at least one said duct so that magnetic attraction between said at least one magnetic means and said at least

one magnetically responsive means will provide at least a portion of said successive opening. Preferably, said at least one magnetic means comprises at least one electromagnet. One preferred example of said at least one magnetically responsive means comprises at least one flexible permanent magnet means secured to at least one said duct. Another preferred example of said at least one magnetically responsive means comprises a liquid containing a suspension of magnetically responsive particles, said liquid being disposed for enabling said suspension to be subjected to at least one magnetic field.

It will be appreciated that a pump or motor of the present invention can be regarded as reciprocal modes of operation of apparatus.

The present invention, in effect, "inverts" the geometry of the conventional peristaltic pump. Thus, a pump of the present invention can produce flow of fluid by means of a travelling dilation in a normally closed peristaltic passage, whereas a conventional pump operates by means of a travelling occlusion in a normally open peristaltic tube.

At least one peristaltic passage in the present invention can be used to give a metered flow rate. Thus, because a preferred feature of the present invention is a fixed degree of opening of a peristaltic passage, the inventive pump is well suited for applications demanding a fixed or metered delivery over a long period of time. For small or very small flow rates the pump may be modified so that the metered quantity(s) can be achieved without recourse to small passages, minute openings or especially slow operating speeds which are all difficult to maintain consistently in practice.

Peristaltic pumps have inherent delivery pulses. In a conventional roller-peristaltic pump, when the peristaltic tube is 'open' at its outlet end, the pressure roller approaching this end is pushing a steady stream of liquid in front of it at the delivery pressure. Behind the occlusion under the roller, the liquid is at 'suction' pressure. Eventually the roller reaches the end of the active section of the tube, for a moment blocks the tube, and then passes over the outlet end. At this moment, the liquid which was enclosed behind the roller at 'suction' pressure is suddenly exposed to the delivery pressure. This results in a 'kick back' as the resilient tube expands and adjusts itself to the new higher pressure while the next roller in sequence becomes the 'delivery' roller. This 'kick back' introduces a complication for metering.

A 'kick' or pulse is an inherent feature at the outlet ends of all peristaltic pumps, and is a feature of the inventive pump. But, if the inventive pump is made with say a plurality (e.g. two) of nearly identical peristaltic passages, with one delivering in a loop back to the inlet of the other, the delivery pulse and the inlet pulse can be made to coincide and cancel each other much more easily in the inventive pump than in the conventional roller pump where there has to be a positional overlap (rather than a timing overlap) to maintain an occlusion in the pump. This concept of using the one half of the pump to feed the other is a way of solving the problem of achieving a tiny delivery flow from the pump as a whole. Unless the two passages are absolutely identical (almost an impossibility to achieve in practice and very easy to overcome if it did happen) there is bound to be a mismatch in delivery which gives a progressive build up in volume at one end and a progressive reduction in trapped volume at the other end between the two positive displacement components, so that a tapping into the pump at these points would give an overall flow through the pump. Each 'half' is now dealing with a reasonable volume throughput so that small leakages in each due to imperfect occlusion become relatively unimportant and the passage manufacturing tolerances remain reasonable. The metered external delivery though is small as it is only the difference between the individual flows. For any individual pair of passages, the pump output can be varied within limits by increase or decrease of the cycling speed of the dual passages.

In the accompanying drawings, which are by way of example of the present invention:

Fig. 1 shows a closed passage cross section in a peristaltic duct.

Fig. 2 shows Fig. 1's passage when fully open.

Fig. 3 shows an open passage cross section in a bellows peristaltic duct.

Fig. 4 shows pump, motor, or valve apparatus comprising the duct of Fig. 3.

Fig. 5 shows another pump, motor, or valve apparatus comprising the duct of Fig. 3.

Fig. 6 shows a further pump, motor, or valve apparatus comprising the duct of Figs. 1 and 2.

Fig. 7 shows another pump, motor, or valve apparatus for the ducts of Figs. 1 to 3.

Fig. 8 shows electrical circuitry for the apparatus of Figs. 5 to 7.

Fig. 9 shows a timing diagram obtained by the circuitry of Fig. 8.

In Fig. 1, peristaltic duct A comprises flat strips 1, 1a of suitable resilient material (e.g. plastics or metal) welded or otherwise hermetically sealed along their adjacent edges 2, 2a to give a leak proof peristaltic passage 3 in duct A. The free state of passage 3 is a closed or collapsed cross section as shown in Fig. 1. Fig. 2 shows passage 3 with an open or expanded cross section. The maximum open cross section of passage 3 can be constant along duct A. But, any variation of the maximum open cross section can be provided in the duct's longitudinal direction to give a chosen amount of internal compression in a compressible fluid as it travels along passage

3. The lower or upper outer surface(s) of strips 1, la have an optional key portion 4 (one is shown). A single key portion 4, or a plurality of key portions 4 spaced apart, can extend longitudinally of strip(s) 1, la by any required amount for keying duct A to a supporting substrate (Fig. 6). Opening of passage 3 may be somewhat dependent on resiliency of strips 1, la remaining unchanged if opening forces are applied in arrowed direction on sides 2 and 2a. Alternatively, some actuators for closing or opening cross sections of passage 3 are rigid or semi rigid substrates to be attached to the respective lower or upper outer surface(s) of strips 1, 1a, e.g. by adhesive or brazing. One or both substrates can be moved to give closings or openings of passage 3. Preferably, at any given cross sections, passage 3 is opened exactly or substantially the same amounts such that peristaltic flow of fluid through passage 3 is relatively insensitive to the resilient closures of passage 3.

In Fig. 3, bellows peristaltic duct B comprises flat strips 21, 21a, 22, 22a, 23, 23a of suitable resilient material (e.g. plastics or metal) welded or otherwise hermetically sealed along their adjacent edges to give a leak proof peristaltic passage 24. The free state of passage 24 is a closed or collapsed cross section. The open cross section of passage 24 is shown in Fig.3. The maximum open cross section can be constant along passage 24; but, any variation of the cross section (in either maximum opening or in closing of passage dimensions) can be provided in the duct's longitudinal direction to give a chosen amount of internal compression in a compressible fluid as it travels along passsge 24. The lower or upper outer surface(s) of strips 21, 21a have an optional key portion 25 (one is shown). A single key portion 25, or a plurality of key portions 25 spaced apart, can extend longitudinally on strips 21, 21a by any required amount for keying duct B to a supporting substrate (not shown). Some actuators for closing or opening cross sections of passage 24 are rigid or semi rigid substrates to be attached to the respective lower or upper outer surface(s) of strips 21, 21a, e.g. by adhesive or brazing. One or both substrates can be moved to give closings or openings of passage 24. The actuator substrates may be actuator shoes 31 (Fig. 4). Opening of passage 24 is somewhat dependent on flexibility of strips 21, 21a, 22, 22a, 23, 23a. Preferably, at any given cross sections, passage 24 is opened exactly or substantially the same amounts such that peristaltic flow of fluid through passage 24 is relatively insensitive to the resilient closures of passage 24.

In Fig. 4, pump apparatus C comprises a bellows peristaltic duct B with actuator shoes 31 spaced apart along and attached to the upper outer strip 21a of duct B for cyclically compressing localised regions or zones of passage 24 in duct B. In this example, four actuators 31 are used but any suitable number of actuators more than three may be used. The sole of each shoe 31 is attached (e.g. by keying, adhesive, or brazing) to the strip 21a. A respective push/pull rod 32 is connected at its lower end by a cross head pin 33 seated in adjacent upwardly directed slots 34 provided in cross head portions 31a, 31b rising from the corresponding shoe 31. The upper ends of the rods 32 are secured to corresponding cranks 35 of a crank shaft D. The cranks are angularly spaced 90° in a spiral sequence with respect to each other to define a four throw arrangement for predetermined ascent or descent of each rod 32. In order for any shoe 31 to close for a required period of time the corresponding cross sectional region of passage 24 (to maintain a seal in passage 24 between its inlet and outlet ends), the required dwell of the respective crank takes place in sequence for each shoe 31 from at least 45° before bottom dead centre to at least 45° after bottom dead centre on the same crank. Each rod 32 has a hollow interior containing a respective compression spring 36 whose lower end bears on the respective cross head pin 33, which is free to move upwards against the resultant spring biassing but is subject to the upper constraint provided by slot 34. When any rod 32 descends its shoe 31 exerts compression on the upper outer surface 21a of duct B, thereby closing the corresponding passage cross sectional region or zone and displacing fluid sideways. The displaced fluid is therefore available to flow along passage 24. Descent of any rod 32 and its shoe 31 continues until the passage zone is completely closed. The shoe 31 and pin 33 then come to rest or dwell, but the lower end of rod 32 is able to continue descending with slot 34 moving downwards over pin 33. After the rod 32 has passed its bottom dead centre, the cross head pin 33 remains stationary until the lower end of slot 34 ascends to cause the pin 33 to ascend. During this time the shoe 31 will have sealed the underlying passage zone, and the next shoe 31 in the spiral sequence will have risen to enable opening of its underlying passage zone and thereby tend to draw a fresh input of fluid to that zone. The cyclic compressions and expansions of passage 24 will be in sequence with rotation of crank shaft D. If desired, the apparatus of Fig. 4 can be operated as a motor or expander to obtain mechanical work from a pressurised fluid.

In Fig. 5, pump apparatus E comprises a bellows peristaltic duct B whose lower outer strip 21 is attached (e.g. by keying, adhesive or brazing) to the upper surface of stationary anvil 41 made of nonmagnetic material and having embedded therein pole pieces 42, 42a, 43, 43a, 44, 44a of suitable shape(s), e.g.

generally triangular, of electromagnets 45, 46, 47. The pole pieces may be flush with the upper surface of anvil 41, or recessed in it, or stand proud therefrom. The upper outer strip 21a of duct B has vertically movable permanent bar magnets 48 attached thereto (e.g. by keying, adhesive, brazing, integral moulding, double sided adhesive tape, Velcro tape— VELCRO is a registEred trade mark, or any other mechanical means). Magnets 48 may be arranged in groups in the vicinities of the pole pieces or run continuously along the length of strip 21a. Magnets 48 may be of platelike construction with gaps between individual plates so as to allow for compression or expansion of duct B, or be a series of bar magnets spaced apart or linked together in flexible manner. The poles of magnets 48 are arranged such that all of those magnets in the group adjacent a particular electromagnet have the same magnetic orientation to enable all the North poles to lie along one edge of duct B, e.g. adjacent the pole pieces 42, 43, 44 and the South poles adjacent the pole pieces 42a, 43a, 44a. When a current passes through the coil of any of the electromagnets (e.g. 45), the magnetic effect produced in the corresponding pole pieces (e.g. 42, 42a) will attract or repel the corresponding permanent magnets 48, causing them to move and open or close the corresponding region or zone of peristaltic passage in duct B. Reversal of the current flow will reverse that movement. If the current supplied to the electromagnets is changed in direction after a given time interval, and in a given sequence to give a travelling wave effect, pumping of fluid will be produced in duct B. When the pumping occurs, the fluid pressure at the inlet of duct B will be less than the fluid pressure at the outlet of duct B. This implies that the electromagnet/-permanent magnet combination at the inlet end of duct B requires to do more work on the opening or repulsive stroke than on the closure or attractive stroke between e.g. magnets 48 and pole pieces 44, 44a, if the fluid inlet is at that end of duct B. However, the electromagnetic pull required to close the peristaltic passage in duct B against the output fluid pressure at the duct end adjacent electromagnet 45 will need to be greater than the effort to open the peristaltic passage in this region or zone. The coils of the electromagnets may be double wound to give a bias, or a second set of permanent magnets (not shown) may be attached (e.g. by adhesive or brazing) to a non-magnetic structure above the magnets 48 and with the magnetic poles of the second set arranged to assist movement of magnets 48, depending on which direction fluid is intended to flow through duct B. If a said magnet bias system is provided, the apparatus may operate in reverse flow mode but at reduced efficiency. The magnetic flux produced at the pole pieces may be concentrated to focus lines of magnetic force to pass through the poles of magnets 48. Improvement in magnetic focus and hence improvement in attractive and repulsive forces for a given electrical current may be obtained if suitably shaped, e.g. triangular, items of soft iron or other suitable magnetic material are positioned above magnets 48 so as to allow some movement but with the geometry arranged so that the ends 50, 50a, 51, 51a, 52, 52a of these additional flux concentrating pole pieces achieve an effective influence on the magnetic flux distribution of adjacent electromagnets. The influence of these pole pieces or flux concentrators is improved if they are associated with electromagnets 53, 54, 55, which are similar to electromagnets 45, 46, 47 but connected so that if e.g. electromagnet 45 is exerting a repulsive force on magnet(s) 48 then electromagnet 53 is exerting an attractive force on the same magnet(s) 48, and so on through the apparatus, with electromagnets 53, 54, 55 being switched on in the same sequence as for their mirror images but with current flow that aids movement of the magnets 48, and hence of the corresponding portion of the upper outer strip 1a of duct B.

In Fig. 6, pump apparatus F comprises a peristaltic duct A of Figs. 1, 2, when having a key portion 4 attached to or integral with the lower outer surface 1 of duct A. Key portion 4 is keyed into a keyway 61 in the upper surface of a stationary anvil 62. Attached to or integral with the upper outer surface 1a of duct B is a flexible longitudinal pocket 63 containing a permanent magnet 64 that is a flexible strip of ferro-magnetic material having North and South magnetic poles in the vertical plane of Fig. 6. Anvil 62 is of ferro-magnetic material such that the attractive force between magnet 64 and anvil 63 gives a positive closing force between walls 1, 1a of duct B. At least three (four are shown) electromagnets 65, 66, 67, 68 are arranged in series adjacent to pocket 63. Energising any electromagnet will produce a force on magnet 64, if this force is attractive on the upper outer surface 1a of duct A so as to open the corresponding portion of peristaltic passage in duct A. The pumping cycle starts with energising of electromagnet 65 (which is located at the inlet end of duct A) so as to let fluid enter the corresponding portion of peristaltic passage. Electromagnet 66 is then energised, with electromagnet 65 being partly or wholly deenergised. Electromagnet 67 is then energised, with electromagnet 66 being partly or wholly deenergised, and electromagnet 65 deenergised if its current is not already absent. Electromagnet 68 is then energised, with electromagnet 67 being partly or wholly deenergised, and electromagnet 66 deenergised if its current is not already absent. The result of the successive operating of electromagnets is that the maximum passage opening in duct A

moves from electromagnet 65 to electromagnet 68, i.e. from the inlet to the outlet of duct A, with the result that fluid is pumped through and out of duct A. The reclosing force acting on the peristaltic passage comprises the magnetic attraction between magnet 64 and anvil 63, but the reclosing force can be aided or provided by reversal of current flow in the electromagnet(s).

In Fig. 7, a peristaltic duct (e.g. according to any of Figs. 1 to 3) passes through a torroidal chamber 71, via the inlet and outlet thereof which are sealed by glands or seals 72, 73. Chamber 71 can be evacuated to any reduced pressure (e.g. subatmospheric) to expand the cross section of the peristaltic passage to e.g. a fully open state. This expansion arises from the difference between the pressure in the peristaltic passage and the pressure in chamber 71. Around the exterior are at least three (four are shown) spaced apart electromagnets 74, 75, 76, 77 having pole pieces (e.g. 74a, 74b) straddling the torroidal cross section. Chamber 71 contains a sufficiency of liquid containing a suspension of magnetically responsive particles, e.g. a liquid composition available under the trade mark FERROFLUID. When the liquid/suspension is subjected to an attractive magnetic field, the internal pressure of the liquid/suspension is a function of the strength of the field. When an electromagnet (e.g. 74) is energised, the concentration of the liquid/suspension between the corresponding pole pieces (e.g. 74a, 74b) will exert a pressure. The field strength and volume of the liquid/suspension are chosen so that pressure will be sufficient to close the region or zone of the peristaltic passage adjacent the pole pieces, and thereby provide a seal in the peristaltic passage and give isolation between the inlet and outlet pressures of the fluid in the peristaltic passage. If the electromagnets are energised sequentially (with appropriate deenergisation), the occluded region or zone of the peristaltic passage will travel along the length of the duct, under the influence of the rotating pressure waves in the liquid/suspension of chamber 71.

The sequential supply of current to energise the electromagnets of Figs. 5, 6, 7 can be provided in any suitable manner. One example of that provision comprises mechanical opening and closing of contacts, for instance of a plurality of rotary switches driven by an electric motor. Another example of the provision is provided by solid state components, for instance as shown in Fig. 8, which is for a three electromagnet arrangement similar to that of Fig. 5. In Fig. 8, a pulse generator 81 emits a series of electrical pulses for timing purposes. The frequency of the series of pulses is controlled by a capacitor 82 and a variable resistor 83. The pulses are inputted to two decade counters 84, each of which triggers at each decade to pass a respective electrical signal to each of two timer units 84, each of which provides respective output signals to change the base bias voltages of two pairs of transistors 85, 86, which act as switches to change direction of current in an electromagnet. The decade counters 83 cascade the counting so as to conform to the required pattern of electromagnet energisation, e.g. whereby one electromagnet switches at a period that overlaps the switched state of the electromagnet controlled by the previous decade. Fig. 9 shows one example of a said overlap, as shown by the distance between X and Y.

The present invention includes equivalents and modifications of the description with reference to the drawings. The present invention also includes equivalents and modifications of the description given above before the first reference to the drawings.

CLAIMS

1. A peristaltic duct (e.g. for a peristaltic pump or motor or valve), said duct being adapted such that its relaxed or unstressed state is occlusion of the peristaltic passage so as sufficiently to close the cross section of said passage, at least one opening force being applicable to said duct so as to open said cross section and allow flow of fluid therethrough.

2. A duct as claimed in claim 1, when disposed at least partly linearly.

3. A duct as claimed in claim 1 or 2, when disposed at least partly toroidally.

4. A duct as claimed in any one of claims 1 to 3, when tubular.

5. A duct as claimed in any one of claims 1 to 3, when bellowslike.

6. A duct as claimed in claim 1, substantially as hereinbefore described with reference to and as shown in Figs. 1, 2 of the accompanying drawings.

7. A duct as claimed in claim 1, substantially as hereinbefore described with reference to and as shown in Fig. 3 of the accompanying drawings.

8. A peristaltic pump, motor or valve, comprising: at least one peristaltic duct of any one of claims 1 to 7; and at least one stress means for stressing said at least one duct so as to open at least one said cross section and allow flow of fluid therethrough.

9. A peristaltic pump, motor or valve as claimed in claim 8, wherein said at least one stress means is adapted to open a predetermined succession of said cross sections of the peristaltic passage of at least one said duct.

10. A peristaltic pump, motor or valve as claimed in claim 9, wherein said at least one stress means comprises at least one crank means; and at least one connecting means communicating between said at least one crank means and at least one said duct so

that at least one rotational movement of said crank means will provide at least a portion of said successive opening.

11. A peristaltic pump, motor or valve as claimed in claim 10, wherein said at least one connecting means comprises connecting rod means.

12. A peristaltic pump, motor or valve as claimed in claim 9, wherein said at least one stress means comprises at least one magnetic means; and at least one magnetically responsive means for magnetic communication between said at least one magnetic means and at least one said duct so that magnetic attraction between said at least one magnetic means and said at least one magnetically responsive means will provide at least a portion of said successive opening.

13. A peristaltic pump, motor or valve as claimed in claim 12, wherein said at least one magnetic means comprises at least one electromagnet.

14. A peristaltic pump, motor or valve as claimed in claim 12 or 13, wherein said at least one magnetically responsive means comprises at least one flexible permanent magnet means secured to at least one said duct.

15. A peristaltic pump, motor or valve as claimed in claim 12 or 13, wherein said at least one magnetically responsive means comprises a liquid containing a suspension of magnetically responsive particles, said liquid being disposed for enabling said suspension to be subjected to at least one magnetic field.

16. A peristaltic pump motor or valve as claimed in claim 8 substantially as hereinbefore described with reference to and as shown in Fig. 4.

17. A peristaltic pump, motor or valve as claimed in claim 8, substantially as hereinbefore described with reference to and as shown in Fig. 5.

18. A peristaltic pump, motor or valve as claimed in claim 8, substantially as hereinbefore described with reference to and as shown in Fig. 6.

19. A peristaltic pump, motor or valve as claimed in claim 8, substantially as hereinbefore described with reference to and as shown in Fig. 7.

20. A method of peristaltic flow of fluid, comprising utilising at least one peristaltic duct of any one of claims 1 to 7, or at least one peristaltic pump, motor or valve of any one of claims 8 to 19.

Printed for Her Majesty's Stationery Office
by Burgess & Son (Abingdon) Ltd, Dd 8817356, 1987.
Published at The Patent Office, 25 Southampton Buildings,
London, WC2A 1AY, from which copies may be obtained.